MERCURY AND AIR TOXIC ELEMENT IMPACTS OF COAL COMBUSTION BY-PRODUCT DISPOSAL AND UTILIZATION

Quarterly Technical Report

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ABSTRACT

The U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) Program Manager visited the EERC on July 22, 2003, and discussions on methods were held. On August 11–13, 2003, the Energy & Environmental Research Center (EERC) Program Manager attended a review meeting of DOE NETL in-house research related to coal utilization by-products (CUBs) and presented at the NETL Mercury Control R&D Program Review Meeting in Pittsburgh, Pennsylvania. Project researchers presented at the Air Quality IV (AQIV) International Conference on Mercury, Trace Elements, and Particulate Matter held September 22–24, 2003, in Arlington, Virginia. Discussions with other groups performing similar work were held.

The remainder of the work during the third quarter focused on collecting additional samples, performing laboratory tasks, and continuing literature searches.

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AQIV	Air Quality IV
CCB	coal combustion by-products
CUB	coal utilization by-products
DOE	U.S. Department of Energy
EERC	Energy & Environmental Research Center
NETL	National Energy Technology Laboratory
SGLP	synthetic groundwater leaching procedure

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EXECUTIVE SUMMARY

The U.S. Department of Energy National Energy Technology Laboratory Program Manager visited the Energy & Environmental Research Center on July 22, 2003, and discussions on methods were held. The EERC Program Manager and project researchers attended and presented at meetings related to mercury and coal combustion by-products. Discussions with other groups performing similar work were held.

The remainder of the work during the third quarter focused on collecting additional samples, performing laboratory tasks, and continuing literature searches.

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INTRODUCTION

This effort by the Energy & Environmental Research Center (EERC) is focused on the evaluation of coal combustion by-products (CCBs) for their potential to release mercury and other air toxic elements under different controlled laboratory conditions. The effort will investigate the release of these same air toxic elements in select disposal and utilization field settings to understand the impact of various emission control technologies. The information collected will be evaluated and interpreted together with past EERC data and similar data from other studies. The proposed work will evaluate the impact of mercury and other air toxics on the disposal and/or utilization of CCBs and provide data on the environmental acceptability of CCBs expected to be produced in systems with emission controls for typical disposal and utilization scenarios. The project will develop baseline information on release mechanisms of select elements in both conventional CCBs and modified or experimental CCBs. The modified or experimental CCBs will be selected to represent CCBs from systems that have improved emission controls. Controlling these emissions has a high potential to change the chemical characteristics and environmental performance of CCBs. Development of reliable methods to determine the release of mercury from CCBs will provide a means of evaluating the environmental risk associated with CCB management practices. Using appropriate methods to develop a data set of currently produced CCBs and CCBs produced under experimental/ simulated conditions will provide a baseline for the CCB industry to understand the impact of various emission control technologies.

EXPERIMENTAL

Experimental work included continued work on development of techniques for mercury speciation, microbiological experiments, and collection of leaching data from column leaching experiments on ammoniated ash. High-temperature emission experiments continued with spiking of ash with known mercury compounds in an attempt to speciate mercury on ash in addition to characterizing the thermal desorption profiles of mercury from project samples.

A set of microbiologically mediated experiments was performed using an eastern bituminous fly ash from an existing system (no mercury emission controls) having a mercury concentration of 0.234 µg/g. The setup consisted of ash mixed with a buffer and inoculum from a local brackish slough. The mercury release was tested from four conditions in triplicate. These conditions were aerobic with glucose, aerobic without glucose (starved), anaerobic with glucose, and anaerobic starved. Two traps were used to capture the released mercury from each flask. A Carbotrap tube was used to capture methylated mercury, and a gold-coated quartz trap captured the elemental mercury. A bacterial count was also performed upon completion of the experiment.

In an associated project, column leaching experiments were performed to look at the transformation of ammonia to nitrite and nitrate from an eastern bituminous fly ash. The column was run for 10 weeks with leachate collected on a weekly basis. The leachate was analyzed for ammonia, nitrate, nitrite, pH, sulfate, and trace elements. A column was also set up with ash above soil. Researchers are currently reviewing the ash/soil data to determine if it is relevant to this project.

Assembly of data on mercury releases from CCBs is nearing completion, and these data are being summarized for presentation to project sponsors.

RESULTS AND DISCUSSION

The U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) Program Manager visited the EERC on July 22, 2003, and discussions on methodology were held.

Discussion and selection of leaching methods continued. Ann Kim, DOE NETL, was contacted and explained the proposed NETL leaching method. The EERC Project Manager agreed to participate in a NETL Merit Review, where this method will be discussed. Further, the EERC has agreed to participate in a testing program that will include the EERC synthetic groundwater leaching procedure (SGLP)–long-term leaching methods, the NETL leaching method, and the EPA-proposed leaching method. Data will be shared and be available to this project.

On August 11, 2003, Program Manager Debra Pflughoeft-Hassett attended a review of DOE NETL in-house research related to coal utilization by-products (CUBs). Discussion with NETL staff resulted in an agreement to participate in an interlaboratory study evaluating leaching methods including SGLP and long-term leaching, a method under development at NETL, and the recommended EPA mercury-leaching methods. A meeting was tentatively scheduled for October 2003.

Debra Pflughoeft-Hassett attended the NETL Mercury Control R&D Program Review Meeting in Pittsburgh on August 12–13, 2003. Ms. Pflughoeft-Hassett presented information on mercury impacts on by-products. Discussions were held with other groups performing similar efforts and with potential suppliers of samples.

Project Researcher Mr. David Hassett acted as a coordinator for a session entitled “Mercury and Coal Utilization By-Products” at the Air Quality IV (AQIV) International Conference on Mercury, Trace Elements, and Particulate Matter held September 22–24, 2003, in Arlington, Virginia. Mr. Hassett and Ms. Loreal Heebink coauthored a paper and a poster presentation at AQIV.

Additional contacts were made to obtain samples from previous mercury emission control demonstrations, including project sponsors and other groups. Sample collection efforts have resulted in a total of 31 samples available for laboratory efforts. The issue of confidentiality of the sample sources may prove to be somewhat limiting in report preparation. In one instance, the sample provider has

requested that the only identifier on the sample be that it contains carbon and that it is from a coal-fired power plant. Continued discussions with the parties involved will hopefully result in a resolution.

The results of the microbiologically mediated release of mercury are shown in Table 1. It does not appear that methylmercury was generated in this experiment. The elemental mercury values are variable, but general trends indicate that more mercury vapor was released under glucose conditions than starved conditions.

Table 1. Microbiologically Mediated Mercury Release from an Eastern Bituminous Fly Ash

	Mercury Released, pg/g		
Condition	Carbotrap	Gold Trap	Bacterial Count/mL
Anaerobic			
Glucose	0.27	3.10	<30
Glucose	0.28	3.55	<30
Glucose	0.25	7.54	<30
Starved	0.26	1.33	<30
Starved	0.45	0.90	<30
Starved	0.40	1.13	<30
Aerobic			
Glucose	0.28	8.11	>24,000,000
Glucose	1.04	35.2	>24,000,000
Glucose	0.26	2.72	>24,000,000
Starved	0.12	0.96	43,000
Starved	0.27	1.59	24,000
Starved	0.09	0.61	150,000

Selected results from the ash column leaching experiment are presented in Table 2.

Table 2. Column Leaching of an Eastern Bituminous Fly Ash

Week	As, mg/L	Cd, mg/L	Cr, mg/L	Hg, µg/L	Ni, mg/L	Se, mg/L
1	0.8998	0.00688	<0.05	<0.01	0.08	0.8956
2	0.9000	0.00441	<0.05	<0.01	<0.04	0.7866
3	0.7516	0.00137	<0.05	<0.01	<0.04	0.6056
4	0.7422	0.00092	<0.05	<0.01	<0.04	0.5734
5	0.7882	0.00074	<0.05	<0.01	<0.04	0.6126
6	1.163	<0.0002	<0.05	<0.01	<0.04	0.8990
7	2.694	0.00021	<0.05	<0.01	<0.04	1.731
8	3.151	<0.0002	<0.05	<0.01	<0.04	1.761
9	3.711	<0.0002	<0.05	<0.01	<0.04	1.607
10	4.280	<0.0002	<0.05	<0.01	<0.04	1.406

CONCLUSIONS

Sample collection and prioritization will continue during the next quarter along with laboratory tests initiated during this quarter. Additional microbiological experiments are planned. A setup to perform ambient-temperature vapor release experiments for 50 containers will be assembled, and those experiments will be initiated. An attempt will be made to determine the high-temperature release of arsenic, selenium, and chromium using the same apparatus used for the mercury emission studies.